Whales as sentinels in a changing marine environment in the Gulf of Alaska

Dr. Bree Witteveen
Dr. Lei Guo
Kate Wynne
Outline

• The GAP project
• GAP Whales
• Three examples
  1. Monitoring of index sites
  2. Spatial and temporal trends in habitat use
  3. Consumption modeling
The Gulf Apex Predator-prey Project (GAP)

• Initiated in 1999 to address questions of biologic and economic concern triggered by dramatic declines in Steller sea lions
GAP Whales

- Apex predators that consume massive amounts of prey
- Major population fluctuations
- Recovery is occurring during times of significant environmental change
- Given the breadth of GAP and related data, we now seek to explore the use of whales as sentinels
Monitoring

• Established three VIS
• Each suited for MTL and UTL monitoring
  – Prey data
  – Known importance to foraging whales
  – Near SSL haulouts
  – Commercial fisheries
Monitoring

- Sampling grids
- CTD casts
- Dual frequency backscatter
- Zooplankton samples
- Whale counts, photos & biopsies
Variability Index Sites

• Monitoring of index sites has already shown substantial differences between just two years
• Replicate surveys provide a means of documenting change
• Returning to Marmot Bay in 2014
Aerial Surveys

• Data: Sightings from Aerial Surveys
  – Directed : mid 2007 to Present

• Explore data for spatial and temporal trends and habitat preferences
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<td>80.1***</td>
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<td>7.8**</td>
<td>67.7***</td>
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Modeling the data

- Grid – 5km²
- Variables
  - SST (mean & var)
  - Chl a (mean & var)
  - Depth
  - Month
  - Year
  - Latitude
  - Longitude
  - ???
Consumption modeling

• In the CGOA, multiple ecosystem drivers have been suggested
  – Fishing and climate change cannot explain majority
  – Leads to the importance of trophic interactions, including whales
Consumption modeling

• Current ecosystem models estimate baleen whales having small roles
• But...models have low resolution
  – Spatial: regional (GOA) vs. mesoscale (10’s to 100’s km)
  – Temporal: annual vs. seasonal
The GAP Approach

- Bioenergetic model
- Summer consumption estimates only
- Meso-scale (near-shore Kodiak)
- Example: ATF vs. Humpback whales
Comparing impacts
ATF vs. Humpback whales

• Similarities
  – Population trends
  – Low exploitation rates

• Differences
  – Mobility
  – Seasonality
  – Life span
  – Consumption ratios (Q:B; 6 vs 1.5)
Comparing impacts
ATF vs. Humpback whales

- Humpback whales $\sim 10.7$ kg km$^{-2}$day$^{-1}$
- ATF $\sim 28.9$ kg km$^{-2}$day$^{-1}$
  – shows great spatial variation
- High for ATF and low for whales?
- Essential to consider in the context of spatial variation
Avg humpback whale consumption = 10.7 kg km\(^{-2}\) day\(^{-1}\)
Avg ATF consumption = 28.9 10.7 kg km\(^{-2}\) day\(^{-1}\)
Next steps

• Use existing framework and hypothetical scenarios
  – Change abundance, diet, prey availability
• Improve whale spatial component using results from habitat model
• How will local energy pathway(s) be modified?
• How much potential impact on SSL?
Looking ahead

• Results have the potential to shed unique insights into roles of whales in marine ecosystems on fine scales
• Diverse methodologies take advantage of GAP’s long time-series data
• Design of future studies and data collection
• Use other available data
  – Stable isotopes, dive behavior
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Foraging Ecology

- Fins ~ Zooplankton
- Humpbacks ~ Capelin
- Overlap when euphausiidiid density very high